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Proceedings of a Benthic Habitat Classification Workshop Meeting of the Maritimes Regional Advisory Process

Maintenance of the Diversity of Ecosystem Types

Benthic Classification and Usage Guidelines for the Scotia-Fundy Area of the Maritimes Region

6-8 January 2004
Nantucket Room, Dartmouth Sportsplex
Dartmouth, Nova Scotia

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Compiled by R. St-Laurent

Compte rendu de la l'atelier sur la classification de l'habitat benthique Réunion du Processus consultatif de la Région des Maritimes

Maintien de la diversité des types d'écosystème

Classification benthique et lignes directrices d'utilisation applicables au secteur de Scotia-Fundy, Région des Maritimes

6-8 janvier 2004
Salle Nantucket, Sportsplex Dartmouth
Dartmouth (Nouvelle-Écosse)

Dr. J. Arbour, Président de réunion

Institut océanographique de Bedford,
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Compilé par R. St-Laurent

December 2004 / décembre 2004

Canada

Foreword

The purpose of these proceedings is to archive the activities and discussions of the meeting, including research recommendations, uncertainties, and to provide a place to formally archive official minority opinions. As such, interpretations and opinions presented in this report may be factually incorrect or mis-leading, but are included to record as faithfully as possible what transpired at the meeting. No statements are to be taken as reflecting the consensus of the meeting unless they are clearly identified as such. Moreover, additional information and further review may result in a change of decision where tentative agreement had been reached.

Avant-propos

Le présent compte rendu fait état des activités et des discussions qui ont eu lieu à la réunion, notamment en ce qui concerne les recommandations de recherche et les incertitudes; il sert aussi à consigner en bonne et due forme les opinions minoritaires officielles. Les interprétations et opinions qui y sont présentées peuvent être incorrectes sur le plan des faits ou trompeuses, mais elles sont intégrées au document pour que celui-ci reflète le plus fidèlement possible ce qui s'est dit à la réunion. Aucune déclaration ne doit être considérée comme une expression du consensus des participants, sauf s'il est clairement indiqué qu'elle l'est effectivement. En outre, des renseignements supplémentaires et un plus ample examen peuvent avoir pour effet de modifier une décision qui avait fait l'objet d'un accord préliminaire.

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SUMMARY

On 6-8 January 2004, approximately 66 scientists, managers, industry representatives, academics and Non-Government Organization (NGO) representatives met in Dartmouth, Nova Scotia, to review the applicability of a proposed benthic classification system for the Scotian Shelf. The proposed system is based on the Southwood Model utilizing the Disturbance/Adversity grid to characterize the benthic ecosystem. Participants discussed and assessed the adequacy of the input parameters that were utilized to construct the model as well as the classification product produced from it. Comparison of the classification with known benthic types/communities indicated strong concurrence in some areas. However, there were still enough incongruities to indicate a need for further development work. Presentations were also made by the World Wildlife Fund (WWF) on their approach, providing some contrast to the type of approach advocated in the proposal. In addition presentation was made on human use/impacts in order to initiate discussion on the linkage between the ecosystem classification and human use/management.

Participants in the meeting identified a series of next steps to be followed, including establishment of a number of working groups to address some of the scientific and technical elements of the system to examining the use and application of the proposed classification scheme in oceans management. In general the disturbance axis of the grid was accepted, however the adversity axis was seen to be in need of continued development before it could be applied confidently.

A commitment to follow-up meetings to further develop the adversity axis and to examine the application of the model was given by the Department of Fisheries & Oceans.

RÉSUMÉ

Du 6 au 8 janvier 2004, environ 66 scientifiques, gestionnaires, représentants de l'industrie, universitaires et représentants d'organisations non gouvernementales (ONG) se sont réunis à Dartmouth (Nouvelle-Écosse) pour examiner les possibilités d'application d'un projet de système de classification benthique au plateau néo-écossais. Le système proposé est fondé sur le modèle Southwood, qui fait appel à la grille des perturbations/dégradations pour caractériser l'écosystème benthique. Les participants ont étudié et évalué la pertinence des paramètres d'entrée qui ont servi à construire le modèle ainsi que la classification produite par celui-ci. Une comparaison de la classification avec les communautés et types benthiques connus a révélé de fortes concordances à certains égards. Toutefois, il restait suffisamment d'incongruités pour qu'il apparaisse nécessaire de travailler encore sur le système. Le Fonds mondial pour la nature (WWF) a lui aussi exposé son approche, présentant des différences avec le type d'approche préconisée dans le projet. Enfin, un exposé portant sur les utilisations humaines et leurs incidences a servi à lancer la discussion sur les liens entre la classification de l'écosystème et la gestion et les utilisations humaines.

Les participants à la réunion ont déterminé quelles étaient les prochaines étapes à suivre, notamment la mise sur pied de divers groupes de travail chargés de traiter de certains aspects scientifiques et techniques du système ainsi que d'examiner l'utilisation et l'application du mode de classification proposé à la gestion des océans. L'axe des perturbations de la grille a été accepté en général, mais on a jugé que l'axe des dégradations nécessitait d'être mis au point avant qu'on puisse l'appliquer avec confiance.

Le ministère des Pêches et des Océans s'est engagé à tenir des réunions de suivi en vue de travailler sur l'axe des dégradations et d'examiner l'application du modèle.

INTRODUCTION

Since the passing of Canada's Oceans Act in 1997, DFO has undertaken a number of initiatives towards the implementation of ecosystem-based management (EBM) in Canada. One of these was the development of a set of objectives to guide EBM through a national science workshop (February 2001) and follow-up discussion in DFO's National Policy Committee. Conceptual objectives for diversity, productivity and habitat were defined, with that of diversity considering community, species and population levels. As there are a number of human activities (e.g., fishing, oil and gas exploration) that can impact benthic community diversity, Maritimes Region initiated a RAP in 2001 to provide fisheries and oceans managers with guidance on the management of these human activities consistent with the broader, national objectives.

The geographic focus of the review is the Scotia-Fundy area of the Maritimes Region (NAFO areas 4VWX plus 5 up to the U.S./Canada border). Given the additional complexities of data availability within the intertidal zone, the review addresses information beyond the coastal fringe (i.e., deeper than about 10 meters in depth).

The June 25-26, 2001 RAP clarified the main goal, developed a series of nine framework recommendations (believed to be of great interest to the Scotian Shelf resource user groups because of their direct implications), and agreement on the Scotian Shelf large marine ecosystem boundaries for the benthic classification that reflect real and significant ecological separations or transition zones, except for the U.S. border. The workshop also proposed a four-level hierarchical classification scheme where all levels are nested in higher levels and no attribute at one level exists at another level.

Leading up this phase, three half-day workshops took place during May–September 2003 at the Bedford Institute of Oceanography (BIO) to discuss the technical details of the bathymetry-geology-oceanography-biology classification model. At the same time, a science team reviewed the proposed classification map of the benthic "ecosystem types", the categories of impacting human activities and including the measures of the impact of each activity on the benthic "ecosystem types. Based on these discussions, working papers were prepared and circulated to participants prior to the RAP.

The meeting (see Agenda at appendix 2) was structured to present the proposed approach to benthic classification for the Scotian Shelf, as well as another example of an approach used by WWF, prior to looking at the human activities impacting the ecosystem of benthic communities and habitats. The proposed approach to habitat classification is derived from the Southwood (1998) model that captures two major forces (the durational habitat stability (frequency of disturbance) and adversity or severity of the environment) and defines and constrains life-history characteristics of species without imposing uniformity of the traits. The other example presented by WWF involves the mapping of representative and distinctive areas and the subsequent identification of a set of Priority Areas for Conservation (PACs). The ecological units used to achieve habitat representation, called seascapes, are comprised of physiographic and oceanographic enduring features. They capture the fundamental physical and oceanographic conditions that affect the distribution of marine organisms. The presentations on human impacts focused on the quantification of the bottom area affected by fishing as well as the use of Sala et al. (2002) general model, for selecting and determining the size of marine reserves, as an appropriate model for dealing with the management of human activities and impacts on the Scotian Shelf ecosystem.

The second day provided more in-depth information on the stability/adversity axes of the Southwood (1998) model as well as the implications of the geology, oceanographic and biotic indicators in ecosystems assessment and management. The final day of the workshop provided the participants with a variety of perspectives on the progress made so far on classification models, mapping and approaches to ecosystem-based management strategy for benthic ecosystems in the Scotian Shelf.

Participation to this three-day workshop was by invitation, based on expertise and knowledge. Amongst those who participated, four were selected (Bruce Hatcher, Thomas Noji, Mark Costello, and Glen Jamieson) to provide external perspectives to the process, progress made, and what the future holds. A copy of the invitation letter and the list of the participants are included in appendices 7 and 8 respectively.

Review of 1st Benthic RAP Meeting (Dr. Joe Arbour)

Presentation Highlights

The RAP session began with a brief summary of the June 2001 Workshop, which focussed on reviewing existing approaches to classifying/ characterizing benthic communities, presenting and assessing the proposed classification scheme and recommending a benthic classification, including all trophic levels and marine species.

In preparation for that workshop, a Background Paper was distributed to the participants with six recommendations for developing a classification of benthic ecosystem types for the Scotian Shelf, using the current data, information, and knowledge. It described the definition of terms used, the requirement for a marine habitat and ecological classification scheme that addressed the need to protect benthic biodiversity, types of benthic classification schemes, and their applications to the Scotian Shelf.

In addition to the Background Paper, the workshop hosted five presentations on habitat classification approaches:

- the availability of information on benthic macroinvertebrate communities for classifying marine environments on the Scotian Shelf;
- the European Union Nature Information System (EUNIS) habitat classification system for terrestrial and aquatic lands;
- the geological studies and mapping of surficial sediments on the Scotian Shelf;
- the challenges in habitat classification versus mapping; and,
- a U.S. perspective on habitat classification.

The outputs of the workshop produced a consensus on a series of nine Framework Recommendations:

1. Development of a management-oriented model for benthic classification;
2. Set classification scales by capacity for compliance and enforcement;
3. Classify hierarchically and zone adaptively from the upper levels;
4. Use of benthic assemblages as the Minimum Ecological Unit (MEU);
5. Incorporate oceanographic and trophodynamic processes;
6. Incorporate the role of history in classification of benthic habitat;
7. Operationalize classification by mapping enduring habitat units;
8. Map benthic habitats first on the basis of shelf-scale synopses of oceanography, physiography, substratum, commercial fish and by-catch, invertebrates, rare, long-lived and structuring species; and
9. Relate habitat complexity to biodiversity.

In the final activity of the workshop, a proposed hierarchical classification scheme, where all levels are nested in higher levels and no attribute at one level exists at another level was proposed:

- Level 1: Oceanographic domains;
- Levels 2-3: Seabed domains within oceanographic domains; and
- Level 4: Biological communities.

It was also agreed that the primary goal is to define a marine habitat classification framework that spans a range of organizational levels and spatial scales, and that is suitable for development of integrated management plans for large ocean management areas and for planning to preserve marine biodiversity.

Discussion

The discussion that followed the review of the first Benthic RAP meeting was on ecosystem objectives, species diversity, and linkages of this meeting to the ESSIM process.

In order to answer the questions related to the time frame to define and use EOs, it was re-iterated that the broad EOs have already been set by the Dunsmuir workshop, and what needs to be asked and done is to operationalize them at the regional level. DFO Science has made significant contribution to advance the process and it is anticipated these EOs will be used in the very near future (within a year or so), even though impact assessments may take quite some time to figure out.

In regard to species diversity, as a valued characteristic/indicator, it was pointed out this benthic classification process supports the protection of species diversity; however, it is neither the only element nor the only use of the classification framework. One aspect it does not consider/integrate is the anthropogenic activities.

The Benthic RAP process, and specifically this second phase, will feed into ESSIM's ecosystem objectives elements of sustainability (environmental, social & cultural, and economic). Furthermore, the output of this meeting will filter its way into the next ESSIM Forum. It is expected smaller working groups will emerge to further discuss habitat classification schemes, prior to the annual Forum.

CLASSIFICATION MODELS

Overview of Proposed Habitat Classification Approach (Vladimir Kostylev)

Working Paper:

Kostylev, V.E. 2003. *Habitat management template for Scotian Shelf habitat mapping*

Presentation Highlights

Vladimir Kostylev's presentation was on a progress report titled "*Habitat management template for Scotian shelf habitat mapping*", an interdepartmental (DFO – NRCan) horizontal initiative on benthic habitat mapping in the Scotia-Fundy area. The presentation provided:

- a summary of data availability;
- a discussion on data layers used in habitat characterization;
- reasons for the suitability (inclusion/exclusion) of certain data;
- biological information;
- a conceptual model and examples; and
- a discussion of model parameters.

The aim is to provide products that can be used to plan for the installation of seafloor infrastructure and for the resolution of conflicts regarding seafloor use, allowing for a balance between the competing demands of renewable and non-renewable resource exploration and marine conservation. The data, expertise and mapping solutions will meet a broad range of needs of the government, First Nations, oceans industry and resource users, environmental interest groups, coastal communities, and university researchers.

In this interdisciplinary framework on habitat mapping, two key questions are being addressed: (1) Which areas of the seafloor are the most sensitive to human impacts? and (2) How to balance resource exploration and fisheries with available ecosystem services? These questions are answered through detailed mapping and characterization of the seafloor environment based on the current understanding of biological, geological and oceanographic patterns and processes on the Scotian Shelf.

There is an awareness that without mapping, reasonable characterization of benthic habitats is not attainable. The logic of the proposed approach is not to classify and then map, but to map continuous factors, discover discontinuities and ecological significance, and then characterize or zone the seafloor. This is further based on three main concepts: (1) classification and mapping have different purposes; (2) mapping of the classification system is not useful for management; and (3) progress should go from mapping to classification, not vice versa. The presentation focussed on Southwood's (1988) Disturbance-Adversity habitat template, which was first tested on Georges Bank (Kostylev et al. in press). The Southwood Disturbance-Adversity habitat template defines and constrains life-history characteristics of species, without imposing uniformity of the traits. The Disturbance axis reflects intensity of habitat destruction or alteration, or durational stability of habitat in general, and the Adversity axis is related to the severity or unfavourableness of the habitat and factors that pose a cost for the physiological functioning of organisms, i.e., affecting physiological scope for growth.

Ecosystems, like species, may be arranged in patterns against the habitat template, where ecosystem character is a mix of population strategies and their interactions. The habitat template approach to mapping appears both theoretically valid and economical. The benefits to managers are: (i) knowing the life-history traits of an organism such that one could predict its distribution on the shelf, and (ii) knowing the physical conditions in a given area that one could predict likely inhabitants and biodiversity of the area. Thus, mapping of the habitat template also produces the template for ocean management, based on ecological and evolutionary understanding of benthic patterns and processes.

Discussion

Highlights of the discussions and comments raised by the participants, following the presentation, have been grouped under the following five headings: Changes to zonation; Species; Water masses; Data (database & relationship); and, Disturbance/Adversity Model.

Changes to zonation

Changes to zonation, which may be necessary as a result of severe weather conditions, temperature, and other natural [major] factors, may not necessarily be required on a yearly basis: perhaps on a 5-10 year time frame would be sufficient and more appropriate.

Species

There's definitely room for improvement in the level of identification of benthic invertebrates in trawl surveys. One noticeable gap is the disparity between larger and smaller, rarer species. So far 78 species have been identified, and the issue is to find ways to get people to recognize those smaller, rarer species.

Water masses

It was suggested that to illustrate water masses and their relationship with fish community distribution, temperature and salinity could be combined, as salinity variations alone are inconsequential. Water masses have a great deal to do with where the biology is coming from. It was pointed out the intent of the oceanographic information was to illustrate just that.

Data

Although there are other data sets, such as the ones held by the private sector, the data used for this research was from the BIO database.

The validity, accuracy, reliability and methods for data collection are some of the issues which are continuously debated. As an example, the single beam data used for decades by CHS, to map the Scotian Shelf, is flawed with problems/errors in every layer, compare to the more accurate data collection using the multi-beam. Knowing these facts, we need to identify drawbacks with current mapping, eliminate the redundancy of information, identify significant variables that would best capture habitat complexity, such as the slope and grain size, and overcome the reluctance to share mapping data due to the [known] inaccuracies. For these reasons, it should not be expected that we would find strong patterns for biomass or species diversity: the data collection is not uniform and the assemblage may change. Further more, by-catch data for invertebrates, prior to 1999, are not available as there wasn't any requirement to record the data.

In terms of confidence with the data sets, the physical data sets are much more reliable than the biological ones, which are very sparse and poor, compromising statistical analysis and limiting the ability to derive proxy relationships: it's not surprising that things aren't related. If we want to draw lines, we can probably throw most, if not all, of the biological data out, but we can add to it over time and look at it in the future.

Another hurdle that must be dealt with is data sharing. We need agreements to alleviate the tremendous amount of time and efforts it takes to obtain and share data, without infringing on copyrights.

Disturbance/Adversity Model

The Disturbance –Adversity template defines and constrains life history characteristics of species, without imposing uniformity of the traits. The disturbance axis reflects intensity of habitat destruction or alteration, or durational stability of habitat in general. Adversity is related to severity or unfavourableness of the habitat and factors that pose a cost for physiological functioning of organisms.

In the Cape Breton area, the template shows stability even though there has been a great deal of change in that area, whereas an area of the Scotian Shelf shown as "stable" (where we have the most species distribution) has seen species changes temporally. Therefore, there are some counter-intuitive patterns emerging between the model and shelf changes. Perhaps a small change in an area is a

critical change in the system, when in others they are not. Sensitivity of species assemblages to different parts of the temperature range differ: the greatest variability in assemblage diversity may occur in areas of lowest temperature variability, because the variability is at a particular range. An ongoing classification of where biogenic structures are, such as horse mussels, sponges (Russian hats) in the basin, burrows for various organisms and molluscs, is very important to validating these classifications.

We need to understand what controls the Disturbance and Adversity of benthos to derive deterministic models (it is important not confuse correlation and causality). Disturbance and Adversity are likely not orthogonal, because at least some kinds of disturbance (or disturbance regimes) constitute one kind of adversity, and will vary both quantitatively and qualitatively among habitat types. Disturbance in one habitat will be disruptive, whereas in another it will go largely unnoticed.

The emphasis is to differentiate between natural and human impacts in the mapping of the model, as "Disturbance" in aquatic ecosystems is at the very least complex. The community actually observed in any location would be the product of:

- Natural community succession (a product of: recruitment, natural mortality, predation, competition etc.).
- Natural disturbance regimes (especially physical or biological disruption)
- Natural environmental variation (including forms of adversity?). The key here is the **natural** environmental **variation**
- 'Adversity' i.e. the degree to which the environment is benign or adverse. This is a function of 'static' conditions NOT variation
- Human impacts on the local community. These can take many forms and may or may not mimic effects under a and b above.

The bottom line is that we want management tools/guidance to manage the effects of human activities. The question is whether the model gives enough information, in terms of patterns/structure and biological data, to be conservative enough to protect the seascapes.

A Framework for the Application of Marine Classification for Conservation (Bob Rangeley)

Working Paper:

> World Wildlife Fund Canada and Conservation Law Foundation. A Planning Framework for Marine Conservation. Maintenance of the Diversity of Ecosystem Types: Benthic Classification and Usage Guidelines.

Presentation Highlights

World Wildlife Fund Canada (WWF) and the Conservation Law Foundation (CLF) advocated a two-pronged approach to conservation that includes both sustainable use of resources and the protection of marine life and habitats. They have committed to a joint conservation project aimed at protecting marine biodiversity in the Gulf of Maine/Scotian Shelf region in waters governed by both Canada and the United States. At present, the region does not receive the minimum protection required to maintain biodiversity. The current array of fisheries management measures and the limited nature of existing protected areas have achieved some conservation success, but have failed to stem current threats to biodiversity. It is now recognized that the establishment of ecologically based networks of marine protected areas (MPA) can help protect biodiversity and contribute to sustainable fisheries. Such networks and the integrated management of marine resource use should be nested within an ocean zoning framework. Classification of the marine environment is essential to establishing ocean zoning.

WWF and the CLF have developed a framework for the identification and assessment of priority areas for conservation (PACs) and the eventual design of a network of MPAs for the Gulf of Maine/Scotian Shelf region. Phase I of this framework involves the mapping of representative and distinctive areas for both the benthic and pelagic realms. Representative areas are based on a habitat classification system that divides the region into *seascapes*. MARXAN, an iterative site-selection method, is being used to select high priority distinctive areas for species and ecological processes while simultaneously achieving representation of marine habitats.

WWF and the CLF have a keen interest in achieving meaningful classification of the benthos. This presentation reflects WWF and CLF planning framework for marine conservation and view of the role of habitat classification for making effective ocean management decisions.

Discussion

MPAs are viewed as a multi-zone management area, like *The Gully*, where there is a highly protected central zone and two other zones for uses. WWF is advocating the establishment of MPA Networks, as an alternative to forward-thinking at conservation. Industry should and must be provided with some sort of direction as to where we are going in regard to future [conservation] sites. We could put forth a slate of MPAs, look at them as a network for the next MPA process or look at them in a zoning context. At the moment, there is no map out there for conservation: the approach so far has been ad hoc, and opportunistic.

The WWF/CLF's model of conservation, which evolved to a certain degree from Roff/Day's approach, is a simpler and improved one with fewer variables. The model includes an innovative process (MARXAN) to conservation targets (seascapes), which are ecological units used to achieve habitat representation. Seascapes are surrogates for communities and species because they capture the fundamental physical and oceanographic conditions that effect the distribution of marine organisms. Although there are plenty of quantifiable conservation goals in the literature, there is no clear answer as to how much protection is needed and defendable.

The tool used to help identify *Priority Areas for Conservation* (PAC), based on representative and distinctive areas data, is MARXAN. This tool generates spatial scenarios that satisfy conservation targets based on a percentage of protection within each of WWF's five broad *bio-geographic regions* (Scotian Shelf; Shelf Break; Georges Bank; GoM and BoF; and, Southern New England [partial]).

MARXAN provides the flexibility to use any data combinations (all or specific) for various purposes, such as planning, evaluating, comparing, etc. This tool allows the user to explore different options, modify the output to focus on critical variables, and helps guide decisions. MARXAN works for the coarse grade decisions as well as finer scale decisions. It does not take away the requirement to defend the outcome.

It was suggested that one of the ways this technology could be used to enhance WWF's efforts in identifying and assessing PAC and designing a network of MPAs, was through a participatory process (workshops or other means), which seems to be trend nowadays. We could start and run participatory MARXAN at the small scale, which could take a few hours, keeping in mind the more the variables and the larger the area is, the greater is the risk to run into computational problems.

We could use/force MARXAN to help determine representative areas (conservation features) for the 100-150 seascapes (100 benthic, 73 pelagic) and look into isolated ones that are unique in more details.

HUMAN IMPACTS

Human Impacts Analysis (Dave Wildish and Patrick Stewart)

Working Paper:

> Wildish, D.J., Stewart, P.L. 2003. A geographically-based, ecosystem management strategy for the offshore regions of the Scotian Shelf / Bay of Fundy.

Presentation Highlights

An approach to an ecosystem-based management strategy for benthic ecosystems in the offshore Scotia/Fundy region was presented, which is based on multi-beam acoustics, bottom photography, and sediment mapping, ground-truthed by conventional benthic macrofaunal sampling to detect characteristic habitats and species richness. The overall management goal is to preserve benthic diversity throughout the region. The information will be used in the general model of Sala *et al.* (2002) to select a proportion of the total area of Scotia/Fundy to be allocated as marine reserves, where human activities will be limited. Geographic sub-divisions of offshore regions of the Scotian Shelf in the Scotia/Fundy region, necessary for the process, will be based on approximately forty *conservation planning areas* of unequal size, and *conservation planning units* (a total of 350–800 of unequal size). Choice of conservation planning units (both based on size and total number) will partly depend on an estimate of dispersal distances of larvae of benthic species. Because the proposed methods cannot be applied immediately, we offer some interim management guidelines designed to limit the effects of human activities, particularly benthic trawling, on benthic diversity in the offshore regions of Scotia/Fundy.

Discussion

As an alternative to this proposed approach of marine reserves to measure and/or achieve ecosystem goals, perhaps an analysis of other interim guidelines could prove to be useful, such as mobile gear, effort reduction, closed areas and gear modification. The model arbitrarily divides habitats, which we don't know enough, into geographic units (made of CPUs within CPAs based on multi-beam acoustics) using automated computer optimization techniques. On the outset, it appears there should be an agreement on Units to allow for comparisons within areas.

Area Trawled on Georges Bank by Groundfish Fishery (Stratis Gavaris)

Working Paper:

Gavaris, S., Black, J. 2003. *Area Trawled on Georges Bank by the Canadian Groundfish Fishery*. CSAS Research document 2004/018

Presentation Highlights

The objective of this work is the quantification of the bottom area affected by fishing activity, which may impact the ecosystem by disturbance of benthic communities and habitat. Here, we are concerned with the groundfish fishery on eastern Georges Bank and do not consider gears employed in other fisheries, e.g., scallop, lobster, and herring. Three principal gear types, otter trawl, longline and gillnet, are used in prosecuting the Canadian groundfish fishery. Of these three, otter trawl and longline are the most prevalent gears in use. Most concerns about adverse effects on benthic communities and habitat have centered on the impacts caused by mobile bottom tending gear (Valdemarsen and Suuronen 2003).

Accordingly, the scope of this study is to quantify the area of the seafloor on eastern Georges Bank that is fished by the Canadian bottom otter trawl fishery in a year. The area was quantified using fishing log records and information captured by observers at sea. In 2001 and 2002, the footgear disturbed less than about 10% of the bottom while the bridles/warp swept less than about 30%. The doors impacted less than 1% of the bottom. The available data collected from fishery observations is not sufficient to provide anything but a rough estimate of the area trawled. Comprehensive monitoring of position during fishing operations is required if zoning within management units will be used to regulate ocean use activities.

Discussion

One fundamental question is how we measure and determine adversity/impact on the benthic communities and habitat. There's has been a haddock fishery since 1910 on Georges Bank and it has been the fastest growing stock in the areas where the bottom has been towed: haddock abundance is greater since the late 1960s and it is estimated that by 2006, it will be the highest since the '20s or '30s. Trawling may affect some bottom fisheries/organisms, but it doesn't seem to be affecting haddock or the yellowtail on Georges Bank. Probable causes for the positive impact for haddock may be attributed to the fact that it takes less effort to catch more fish (30,000 pounds of fish caught in 30 hours of effort, including steaming to and from the grounds) and reduced fishing activities in order to bolster market prices, hence an abundance of fish.

Knowing that an ecosystem is dynamic and a decrease in habitat complexity could have effects on commercial species, or on predation, we need to be adaptive in setting up protection measures. Amongst protection measures, we have spawning closures (traditionally on Browns and Georges Banks since the early 1970s) as well as quotas, which may or may not necessarily achieve the outcome of maintaining sustainability and maximizing long-term sustainable yields. A good example of such a disconnect is given by one spawning closure, where in one particular year, all the haddock were spawning outside "the box".

Measuring the intensity of disturbance, based on the available and limited data collected from fishery observation, may not provide a reasonable measure. We know boats usually return to the same areas and tracks, and when observers are aboard there may be different behaviours. This raises the question, which is worse – the same area disturbed or disturbance spread over more areas. Assuming 25% of the bottom is disturbed more than once, we definitely need more comprehensive coverage: we only have 10% observer data coverage and anything east of Halifax, about 10% observer coverage for fleet over 65 ft and since 1984, 95% on fleet under 65 ft long. While different fisheries have different coverage – all foreign vessels are covered and there's high coverage for the silver hake fishery. An alternative to using observers' data, could be the use of a mean tow length; however, the reason that

we are somewhat reluctant to do so, is because of the differences between fisheries - the speed of the boats/trawling is a factor.

In closing the discussion, it was pointed out that data from the fishery industry is indeed available and has been for years, albeit on paper form. The data includes the start, end and locations of tows. Therefore, this data should be retrieved to further this study.

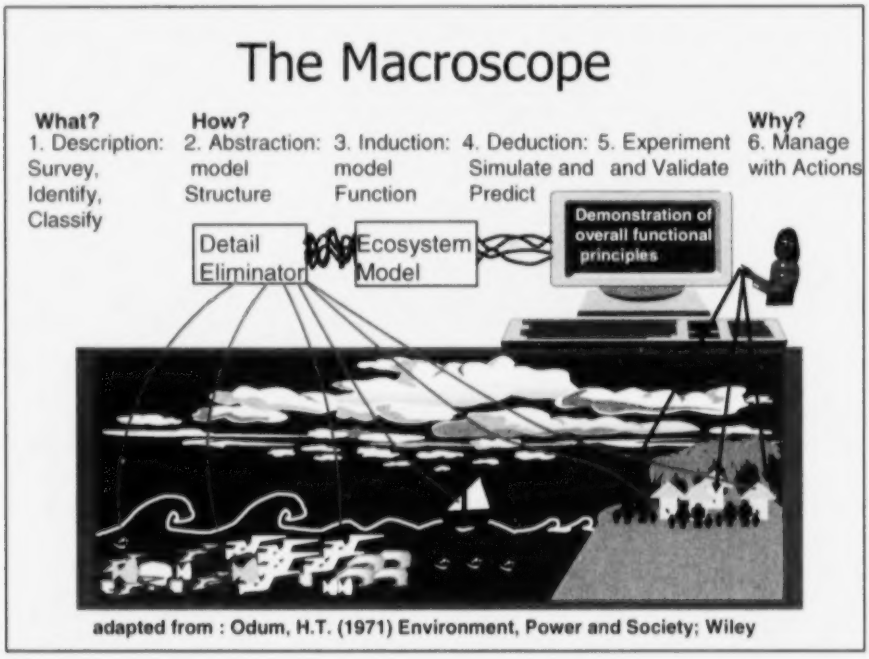
REVIEWERS' COMMENTS ON DAY ONE PRESENTATIONS

External Reviewers: Bruce Hatcher, Glen Jamieson, Tom Noji, and Mark Costello

The External Reviewers gave an overview of the first day regarding the various layers (biotic, chemical, and physical), model and mapping. One general comment was the significant progress made since June 2001, considering this has not been an exclusively in-house process. Their assessments pointed to the usefulness of the model, preferred directions the group should focus on next, including the need to further investigate/elaborate on specific areas of research/findings put forth, and some of the limitations or obstacles to overcome in preserving ecosystem diversity.

The Disturbance/Adversity template and the mapping model of the water masses/columns were particularly found useful: the former for assessing the vulnerability of communities and risks to impacts, and the latter for identifying ecosystem habitat types and classifying thresholds. However, we still need to improve on biological processes and provide management with rates of frequencies of disturbance, recovery rates and vulnerabilities, and an understanding of the energy flow i.e. what one square foot of seabed translates into productivity. Focusing on the temporal aspect of the rates of change would help that process and it would be useful to model the flow of food input into the benthos.

"*Managing what we do*" means we must remain adaptive in our approaches. We don't necessarily want to restrict ourselves to any particular areas, but rather go where activity occurs and where data is most needed. The same principle applies when using existing science and knowledge (macroscope) and selecting the best approach to produce an accurate and defensible delineation of benthic ecological units (objects of conservation management). See illustrations below:



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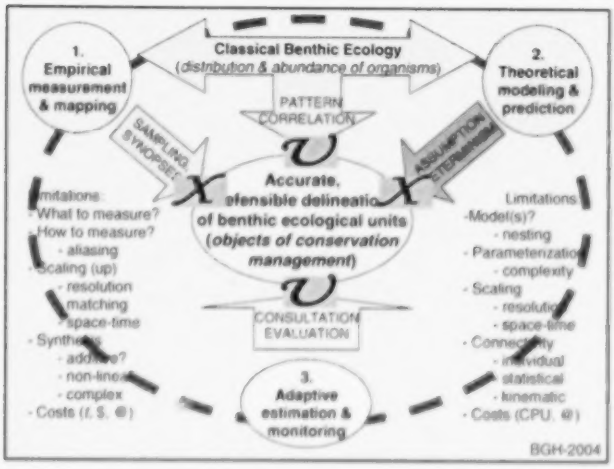

1. Empirical Measurement and Mapping:

Measure and map everything (sampling and synopses)

Limitation: Multi-beam identification of biota.

NOT VIABLE

2. Theoretical Modelling and Prediction:

Don't need to measure. Model from known principles and assumptions determinism.

Limitations: Model characterization, mapping resolution, connectivity without understanding.

NOT VIABLE

3. Adaptive Estimation and Monitoring:

Consultation and evaluation. Monitor assumptions made in a reasonable time.

VIABLE

The external reviewers also talked about what areas should be further investigated. In order to attribute the impact of human activities and how the impact of each activity on the benthic ecosystem types is measured, it is far more predominant to focus on the nature of the impact rather than the quantity. This implies documenting human activity and having an understanding of the equipment used, as well as for DFO to be up-to-date on how ocean industries are evolving, by working closer and interacting with the fishing industry and other users. This would potentially contribute to positive behavioural changes and open the door to more data sharing/surveys. Progress has been made in this collaborative effort to develop an approach for managing the benthic ecosystem and provide fisheries and oceans managers with guidance in the management of their day-to-day activities.

There were also references to some of the limitations to overcome. For one, the "MARXAN" approach may not be perceived to be as transparent as WWF would like to portray it. The use of this optimization tool, which generates scenarios based on data, is subject to interpretation and may be difficult for stakeholders to accept. The question of dedicated resources for a mapping exercise was also raised. Beside the significant lack of coastal data, maps may not necessarily be synchronous if different samplings are employed. In those cases, it will be necessary to determine if solutions are similar, such as WWF's and Vladimir Kostylev's maps, and regularly reviewed with fishermen.

Finally, the feasibility to implement phase three in a reasonable time frame (*provide guidelines and best practices for managing human activities*) promise to be just as challenging, recognizing the decision-making process is very difficult and the diligent task of remaining transparent and convincing. Amongst other things, keep management implications of the model in mind, remember strong regulatory impacts arise from maps, and be cautious of giving "green light" for fishing to go ahead.

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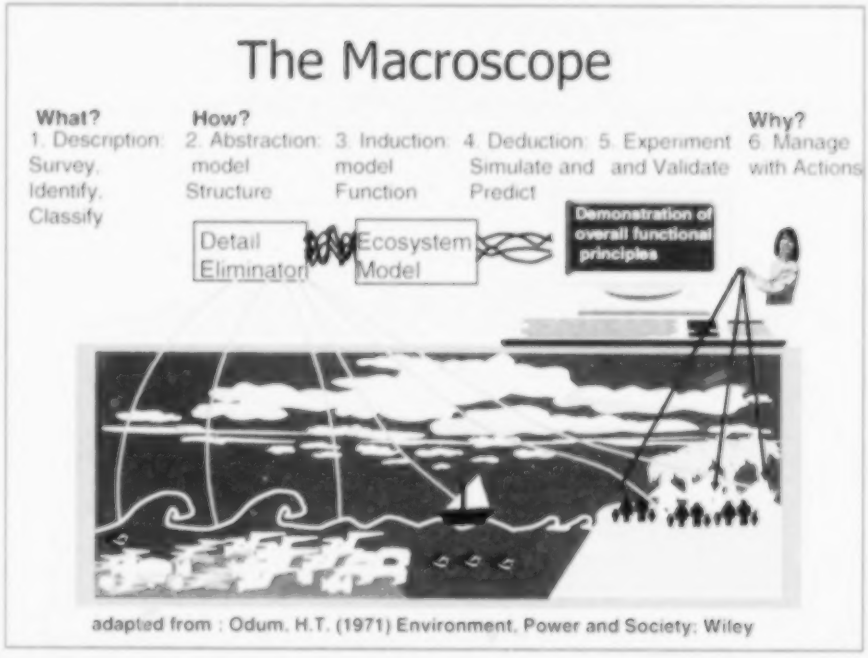

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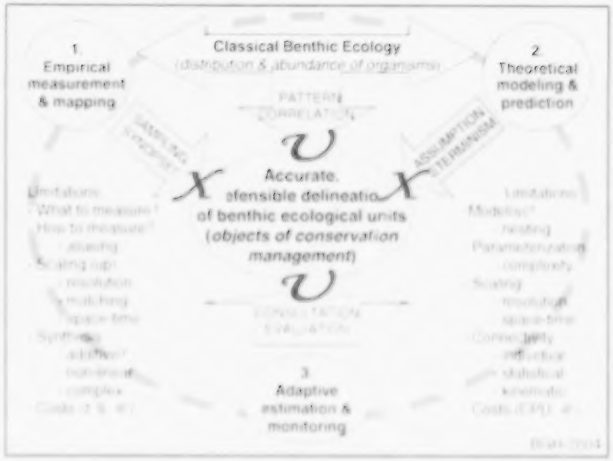

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Discussion

Land-Based pollution vs. offshore

The discussion started off with a question related to offshore activities and the land-based sources of pollution. If all activities were stopped, how much of a change or impact on the ecosystem we would see. Based on empirical evidence and examples provided (such as when the fishing in the North Sea was stopped during World War II) there would be a change, and although we are focusing on the offshore, cumulative effects (what humans are doing globally and how significantly humans impact shelf and offshore, are an important element to factor in. It further emphasizes the purpose/context of knowing and identifying where the impacts are (such as trawling) to maintain biodiversity and manage our oceans. As there is more fishing effort than research, we need to characterize the fishing activity to understand the dynamics (on what basis fishing activity is limited), as well as interacting with managers, users, etc.

Sensitivity analysis

There were concerns expressed about choosing a model without doing a sensitivity analysis, which is in essence part of the defensible aspect of any model: it has to be defensible to scientists and stakeholders. A thorough sensitivity analysis would provide to some degree the sensitivity of the model to the input. We ought to know how a change in the input would affect the model and if significant uncertainty would cause a dramatic change.

Benthic Habitat Mapping Exercise

The discussion then moved to the purposes or uses of the benthic habitat mapping and classification scheme. At the outset, the main purpose of mapping is ocean management and the classification exercise is meant to guide the development of ocean management plans in order to ensure that human activities on the shelf don't reduce or degrade marine biodiversity.

The question was then posed if indeed the map Vlad produced could, as a starting point, be used for management. Some of the feedback suggested that the map indeed appears to capture the spatial patterns (distribution of benthic types) and could possibly classify the benthos. It would seem to be a starting point; however not sufficiently. It is not certain that it adequately captures the disturbance elements, because if there is disturbance in the structure of the bottom, the benthic community would have adapted to that variable. There is also the comparability of natural occurrence to human disturbance (trawling for example): how will it be translated to human activity? We need maps of seabed communities that include community types, activities, and sensitivity and draw comparison to areas where there is no human activity. However, comparison to areas where there is no human activity within MPAs may be misleading. While MPAs are not necessarily no-take areas, they divert activity (as evidenced in the North Sea) to other areas with consequences of being more harmful, such as diverting effort to areas that have never been trawled. We obviously need to be clear with this proposed mapping (3-tier process) of seabed communities. We can be far more certain in describing the habitat in term of structures than the communities – we know what's in there, whereas biological communities are very weakly associated at broad scale, due to the scale of the events (e.g., disturbance regime, etc). Considerations should be given to produce a number of maps to serve specific purposes, such as maps of habitat vulnerability (the adversity – disturbance template is another way of visualizing vulnerability of habitat), a map for different gear types, and/or maps of total allowable trawls per area as in the USA.

The underlying message is, if we want to move along, more analysis (and data) will be required in figuring out where to draw the lines and have a good match. At the moment, it is unclear how the map(s) would convert into management objectives. We don't know what marine community is and what habitat types may be associated – several communities have been associated with specific environments. Physical habitats give us more information than biology right now, albeit we have to understand processes and rates.

SCOTIAN SHELF BENTHIC CLASSIFICATION MODEL

Stability/Adversity Axes (Vladimir Kostylev)

Working Paper:

Kostylev, V.E. 2003. *Habitat management template for Scotian Shelf habitat mapping*

Presentation Highlights

In his introduction, Vladimir Kostylev indicated that this is not the final benthic habitat map. There are other evolving things to consider, such as source-sink, ergocline, and ecotone, the community recurrence and succession history of colonization, human impacts, as well as ongoing issues such as data, resources and agenda to complete the project.

The presentation covered the Stability/Adversity template, which defines and constrains the life history characteristics of species, without imposing uniformity of the traits. The axes of the disturbance and adversity classifiers are continuous:

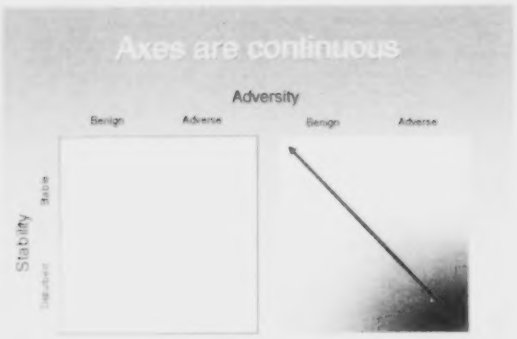
Stability: Frequency of disturbance (Disturbed/Stable) – vertical axis.

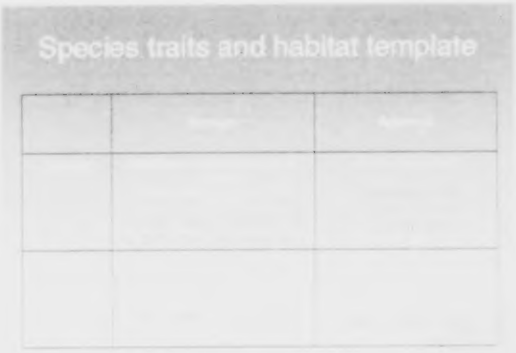
- Although disturbance has been previously defined as (1) mechanisms that limit the biomass by causing its destruction, as well as (2) a discrete, punctuated killing, displacement or damaging of one or more individuals that directly creates an opportunity for new individuals to become established, Vlad defines disturbance in terms of temporal persistence of habitat structure.
- The modeling of the seabed disturbance is based on four factors: seabed grain size, tidal bottom currents, maximum significant wave heights, and periods.
- Wave-generated disturbance is different from the disturbance caused by tidal currents in its spatial distribution and frequency. While tidal motion disturbs seafloor daily, large storms affect the shelf once in a few years.

Adversity: Severity of the environment (Benign/Adverse) – horizontal axis → species traits and ocean management.

- Adversity: Opposite of growth rate and is unfavourable to growth
- Assumptions that traits reflect allocation of energy (low temperature = slow growth and higher risk).
- High variability = risk of reproductive success.
- Low food supply = slow growth & reproduction, and higher risk.
- Poses a particular cost for the maintenance of normal protoplasmic homeostasis and the integrity, and normal functioning of membranes and enzymes (Southwood 1988)
- The template has also been referred to as "severity of the environment", "habitat unfavourableness", "growth rate", "abiotic stress", "resource level".

Overall, the axis is negatively related to the amount of energy available for an organism's growth and positively related to energy spent on adaptation to severe environment, and is the reciprocal of productivity (Southwood 1988).





Mapping of the habitat template also produces the template for ocean management, based on ecological and evolutionary understanding of benthic patterns and processes.

The presentation concluded with the following open-ended questions: Where do we go next? How much time do we spend? Who should be involved? and, appropriateness of the template.

Discussion

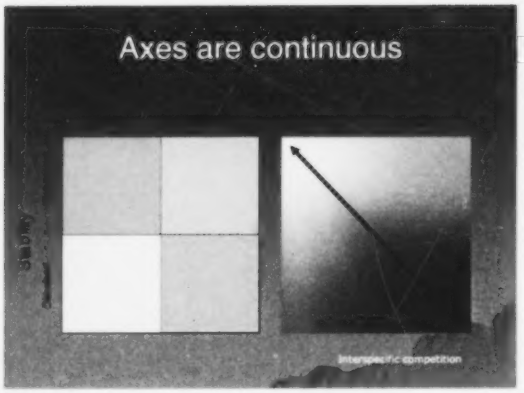
In general, the habitat template is perceived as an appropriate tool, a good step forward in capturing the physical attributes and providing a good sense of the climate. There was however some reservations to use this template as a classification tool, because it does not overlap the biological responses nor does it map small-scale variability – only assumptions of certain traits can be made as more biological sampling … needed. The template seemed to be more readily accepted as an evaluation, a second-level, or a fragility, assessment tool. It was also referred to as more of an ecoclimatic model with some elements of subjectivity, although more so in the stability axis (Disturbed-Stable).

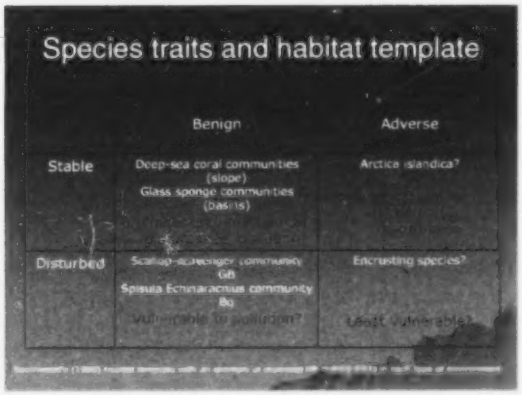
There is also the capability component of the template to consider. Would it account for species that disappear during very adverse situations and come back when those conditions improve? How about communities that have evolved within habitat that is continuously disturbed and for which disturbed habitat is natural? There are also the aspects of uniqueness and multiple habitats within the same areas – there is no one-space specifically identified as a unique environment.

In regard to the mapping of multiple habitats to the same areas, the template would pick up differences in the stability of that habitat once the notion of vulnerability is identified. Organisms in adverse environments are used to greater fluctuations, more physiological changes. The community can be characterized by the species that are stable in that community. A look at the vulnerability of the structure and productivity we are trying to conserve is needed; mobile species are not that relevant to vulnerability.

Obviously we can't measure everything, but need to move forward and accept current limitations. The *scope for growth*, is probably what needs to be assessed, which measures the difference between the amount of energy assimilated from intake and the cost of metabolism (Sebens 1979. Am. Zool. 19:683-697).

For the template model to become a tool to support management decision process, it must go beyond reactive management and management advice, by providing for planning and decision at large scale. This is an opportunity to test the model with MARXAN (a tool that synthesizes large amount of information in an objective manner).





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Geology Indicators (Gordon Fader)

Presentation Highlights

Geoscience Layers in Ecosystems Assessment and Management for the Scotian Shelf

The geoscience layers, which currently provide a geological framework rather than morphological, have been interpreted mostly in a regional context and a few detailed areas. It is weak in the nearshore, banks and other areas, but strong in the basins with cohesive sediments and where Multi-Beam exists. The dominant structuring processes are the glaciation and the Sea-level change.

The presentation included examples of surficial geology to multi-beam bathymetry for the Halifax moraine and the Browns Bank areas from flat to 3D images (based on 10,000 grab samples [no biology] and three million line kilometres of echo-sounder data. No grain size data from inner shelf because of bedrock [500 attempts]). The use of multi-beam brings out the linear features, depression, textures/sediments, and more morphological details (ridging, intrusion, erosion, sub-glacial channel). There are however limitations in terms of interpreting geological history and sediment sources: best for hard bottoms.

It also illustrated a sample of the morphodynamic-temperature regions of the Scotian Shelf using old & new data. The regions are grouped into seven zones:

- Inner Shelf
- Middle Shelf East
- Middle Shelf West
- Outer Shelf
- Shelf Crossing Channel
- Canyons
- Continental slope

The presentation concluded by emphasizing that "*we can't manage what we don't understand*", and for that reason a systematic study of habitats on the Scotian Shelf is definitely needed. The ultimate solution is Multi-Beam/Seamap approach and associated product line to provide the high resolutions for the required precision for habitat assessments. In the interim, we could identify type areas, conduct detailed study of type areas, continue interpretation of existing Multi-Beam, and prepare a shelf-wide habitat mapping plan.

Discussion

There was limited discussion following the presentation. There were two concerns expressed, one related to the geo-bio time-scale mismatches on the *Energy/Time* chart, and the second one with the adversity in reference with geoscience.

Oceanographic Indicators (Charles Hannah)

Presentation Highlights

Using the maps introduced to the participants during Vladimir Kostylev's presentation on habitat classification approach, Charles Hannah demonstrated the physical oceanographic layers in benthic classification. The maps that were referred to included:

- Bathymetry;
- Circulation
- Bottom temperature;
- Seasonal range, T
- Inter-annual variability, T
- Bottom salinity
- Tidal currents;
- Vertical stratification (0-30m)
- Wave heights
- Wave periods
- Productivity regime (Spring surface chlorophyll)

CIRCULATION SCHEMATICS, SOURCES & FLUXES OF WATER MASSES ON THE SCOTIAN SHELF:

While basic circulation is complicated, the primary pathways are the water:

- Coming onto the eastern Scotian Shelf from the Gulf of St. Lawrence and Laurentian Channel
- Coming onto the central shelf from the continental slope
- Leaving the Scotian Shelf via several routes at the western end.

Four water masses meet on the Scotian Shelf:

- Outflow from Gulf of St. Lawrence
- Water from Newfoundland shelf
- Labrador Slope water along the shelf continental slope
- Warm Slope water derived from mixture of Gulf Stream and Labrador Slope water.

Changes to the temperature and salinity on the Scotian Shelf tend to originate from the eastern end or the shelf break.

MEAN BOTTOM TEMPERATURE
Important features are the cold water on the eastern Scotian Shelf, the warm water in the deep basins on the central Scotian Shelf, the tongue of cold water extending southwestward along the coast.

The source of the cold water is the Gulf of St. Lawrence. The source of the warm water is the continental slope. The western Scotian shelf and the Gulf of Maine are dominated by warmer water.

The bottom temperature is the result of the varying bottom depth intersecting the oceanic temperature field that varies in the horizontal and vertical. This is crucially important when one asks what spatial scales are resolved in these maps.

The fields were derived from numerical model solutions forced by the available hydrographic data. The results of two different models on partially overlapping domains (Hannah et al. 2001; Han et al. 1999) were merged for use by Breeze et al. (2002). The grid spacing in the model ranged from 2 km over Browns Bank to 10 or 15 km over Emerald Basin. The underlying bathymetric database had a resolution of 3–10 km and this was smoothed to match the model grid spacing. Thus many small scale features (bumps and holes) were removed that would introduce small scale features into the bottom temperature field. In addition, the initial conditions for the numerical model were also smoother than reality. They were created using optimal estimation to generate a continuous 3-D field from the available data. The smoothing scales range from 5 km across steep topographic features to 100 km parallel to topography. The default smoothing scale over flat topography was 30 km. The numerical model then introduced smaller scales, typically at the edges of banks, due to tidal mixing and other physical phenomena. The resulting temperature field is in balance with the model bathymetry.

The bottom temperature fields were then smoothed during the merging and interpolation from the model grids by Breeze et al. (2002) and then further smoothed by Kostylev.

At what scales are the results reliable? They are reliable at large scales (say >50 km), they are unreliable at small scales (say < 5 km) and the reliability at intermediate scales will be variable. A general warning is in order. The near coastal features in this and other maps are artifacts of the interpolation applied by Kostylev.

RANGE OF SEASONAL CYCLE OF TEMPERATURE

Below 50 or 100 m the amplitude of the seasonal cycle is low. Thus the largest range applies to the shallow area on Sable Island Bank. It should be noted in the report to show that it is not very important over most of the shelf.

MEAN BOTTOM SALINITY

On the Scotian Shelf, salinity increases monotonically with depth. So the map of salinity is approximately a map of depth. In addition there is a general increase in salinity towards the southwest.

INTERANNUAL VARIABILITY BOTTOM TEMPERATURE

An important component of the variability at the bottom is the interannual variability, such as the RMS temperature variability as extracted from the BIO hydrographic database. The largest signal is at the shelf edge and it propagates onto the shelf through the deep channels. The signal is due to variability in the equator-ward extent of the Labrador Slope Water. The RMS amplitude is about 2 degrees. The maximum range is about 8 degrees.

The maps were computed by estimating the RMS variability on a grid with 0.5 degree resolution at 0, 30, 50, 75, 100, 150 m depth below the surface. These vertical slices were interpolated to create the bottom map. It was assumed that the 150 m deep map represented the bottom at all depths below that. The original depth slices are likely reliable at scales of 50 – 100 km and larger.

The map shows more variability over the outer banks than expected. The expectation was that the large signal would be more constrained by the topography around the outer banks rather than over them, as well that there would be more penetration into the Gulf of Maine. This opinion is based on the maps of Loder et al. (2001) that compare the surface and bottom temperatures for the cold 1960s with the warm 1970s. Those maps only considered the region west of the Halifax line. There was insufficient data east of the line to construct reliable fields for the 1960s.

The differences in the patterns have several potential explanations:

- The 0.5 degree gridding is too coarse to resolve the patterns relative to the topography.
- The conversion of the level data to the bottom values introduced smoothing.
- Smoothing was introduced when converting to the presentation grid.
- The spatial patterns reported by Loder et al. (2001) are only one component of the RMS variability.

This exercise is the first application of the RMS temperature fields; as such they have not been carefully examined nor interpreted.

TIDAL CURRENTS AND STRATIFICATION

The tidal currents introduce variability on time scales of hours. For this application the tidal currents are important because they cause bottom stress and vertical mixing in the water column. The bottom stress is a source of disturbance at the bottom and the vertical mixing influences the stratification in the water column.

The map of the RMS tidal currents (Dupont et al. 2002) gives a measure of the spatial variability of the tidal currents. The energy that is being dissipated is the cube of the currents, thus there are several (3-4) orders of magnitude difference in tidal dissipation between southwest Nova Scotia and the area off Halifax (e.g., Hannah et al. 2001).

The tidal currents are also a source of energy for mixing in the water column. The RMS currents map has a close correspondence with the surface stratification map.

The surface stratification was computed by calculating the average density difference between the surface and 30 m on a grid with 0.5 degree resolution. The map presented is the average for July, August and September. The large scale features are correct with low stratification in the west and over the shallow banks where the tidal currents are strongest. The highest stratification is in the east where the fresh water from the Gulf of St. Lawrence has its largest influence.

This stratification map differs from that presented in Breeze et al. (2002) which was based on the model solutions of Hannah et al. (2001) and Han et al. (1999). The primary difference is that the solution of Hannah et al. (2001) shows more stratification over the western Scotian Shelf and Gulf of Maine than does the direct observational based estimate.

MAXIMUM SIGNIFICANT WAVE HEIGHT

The maximum significant wave height was added to give additional information on disturbance. The information was taken from a 40-year hind cast of wind and waves (resolution was 1 degree). The map makes good sense as the wave height is basically a measure of distance from the shelf break and the biggest waves are not generated locally, but propagate in from elsewhere (need a large fetch to get big waves). The shallow offshore banks will tend to extract energy from the incoming wave field.

The waves are important because they can have a significant impact on bottom stress in depths as great as 100 m (and possibly greater). The greater the wave period, the deeper the penetration. However, for a given height and period the impact of the waves will be greater in shallow water than deep water. The use of wave height as a measure of disturbance is a bit crude. One needs to consider the period in order to estimate the magnitude of the near-bottom currents in a particular location (depth). I expect that a map of bottom stress due to waves would show more structure than this map, due to the varying bottom depth. Need to consider the frequency of large wave events relative to important biological time scales, e.g. 1 month or 1 year.

SPRING SURFACE CHLOROPYLL

The immediate impression from this plot is that there is no spring bloom over most of the Scotian Shelf. At a minimum this should be redone with the coastal zone and the upper Bay of Fundy masked out. It would also help to know which months of the year we used in constructing the composite. The lack of masking of regions with no data makes me nervous. I am not sure where the boundaries are between interpolation and extrapolation.

RECOMMENDATIONS

Recommendations for the oceanographic factors as part of the oceanographic gradient calculation:

- Mean bottom temperature – looks good
- Range of seasonal cycle of temperature – remove, not much dynamic range
- Mean bottom salinity – looks good
- Interannual variability bottom temperature – looks too smooth.
- Tidal currents – looks good, might try u^2 or u^3 as a measure of energy.
- Stratification – looks good
- Maximum significant wave height – remove until scaled to account for water depth.
- Spring surface chlorophyll - redo with the coastal areas removed
- Possible additions: Add depth scaled by a reasonable light extinction coefficient.

Discussion

A brief discussion took place following the presentation on the exchange turnover time of the water circulation in the Scotian shelf, the depth-integrated process (water columns) that may affect benthic, and the isoclines of water age, residence time, and transit time, which would have to be depth stratified for much of shelf.

The exchange turnover time is approximately less than a year, and the water sits and flushes every few days. The stratification has a strong seasonal cycle with minimum stratification in late winter. The details of the timing and strength of the stratification varies with location and differs from year to year.

Biota Indicators (Don Gordon)

Presentation Highlights

In concert with Vladimir Kostylev's proposed habitat classification model, Don provided an overview/background of recent BIO benthic studies on the Scotian Shelf. The studies, conducted in a collaborative approach (DFO, NAFC, NRCan, industry, universities, ship time), included:

• The Gully • Sponges • Site selection and calibration studies	• Gear impact experiments: o Otter trawling – Grand Banks and Western Bank; and o Hydraulic clam dredging – Banquereau Bank
• Oil and gas: Georges Bank, Sable Island Bank	• Fish habitat study: o Emerald Bank o Western Bank o Sable Island Bank
	• Deep-water corals: o Channels, canyons, slope in Atlantic Canada

The available tools used during these studies were the TowCam (digital camera which takes picture every 15 seconds), the Campod (use extensively), and the Videograb. It should be noted that a lot of data has been gathered by the oil and gas industry.

The data sets for the period 1997 to 2002 have been collected from 174 Campod and 10 ROPOS Stations, along the continental slope and the Laurentian Channel. The fish habitat study on haddock has six boxes (10X10 kms) sampled optically and with trawl, four of which inside a defined closed area (Emerald Bank and Western Bank). Two "hot" boxes (i.e., lots of fish) & two "cold" boxes (i.e. few fish) sites in the closed area, and one of each outside the defined closed area. The sampling tools used are the Sidescan sonar; QTC IMPACT acoustic seabed classification; BioSonics DT acoustic fish detection; Campod and Towcam (video and photographic surveys of seabed habitat, benthos and fish); IKU Grab and Videograb; and Campelen trawl.

ASSESSMENT OF PROPOSED MODEL: The template seems to pick up major features, as we understand them.

Overall	Fresh approach Quantitative analysis and synthesis of numerous existing data layers Oceanographic, physiographic and geological High data density and relatively uniform coverage so high degree of confidence Shelf-wide coverage with few holes Provides sound theory for predicting the make up of benthic communities (species, life modes, life histories) Different physical forcing functions should lead to different communities Stability, related to sensitivity, seems better developed than Adversity Stability is related to sensitivity Definitions can be improved with time
Oil and gas work	Sable Island Bank: Agree SOEI area is disturbed and adverse, however no apparent difference between shallow and deep sites (Alma vs. Thebaud). Georges Bank: Agree disturbed but more benign. Also gravel pavement more stable than sand.
Gear impact experiments	Agree Western Bank site is more stable and more benign than Banquereau

The Gully	Agree should be relatively stable because of depth but expected to be more benign. Sharp boundaries make sense.
Corals	Agree found in stable areas, but surprised to see the Gully more adverse (depth?) • Shelf edge/Georges Bank: More stable; • *The Gully*: Stable/Adverse is questionable; • Stone Fence: Stable/Disturbed is questionable; • NE Channel: questionable also.
Fish habitat	Agree that habitat becomes more stable and more benign moving from Sable Island Bank westward to Emerald Bank
Other	Agree Sable Island Bank and Banquereau are disturbed and adverse. Site of offshore clam industry. Agree inner basins are more stable and benign. Abundant sponges near The Patch
Shortcomings	Not able to pick up important differences in habitat at smaller spatial scales Difficult to predict by any means, need observation (as in our fish habitat study) Changes in substrate is very important Bedforms How does it pick up or take structure into account in small areas/scales?

SUMMARY

We need to move ahead using existing information to develop a habitat classification useful to our management objectives, which is based on the best science. Need a road map to set future directions and adjust with time as experience is gained. Ideally, we need more data (e.g., SeaMap); however, future resource levels are unclear.

Discussion

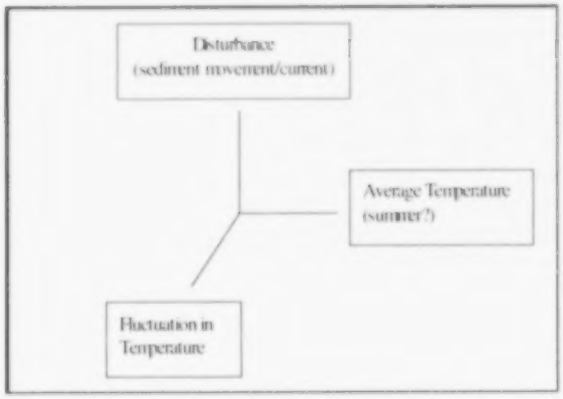
The reason why some correlations between predicted habitat distributions and known organism distributions is poor, is because of a serious scale mismatch between the level at which habitat characteristics are predicted and the scales at which causal relationships operate. On a large scale, assumptions and studies match; however, there is a lack of precision on a small scale. It is therefore relevant not to confuse the testing of the assumptions of the model and of causal relationships between physical factors and D&A of benthic organisms. It was suggested that to ground-truthing the model could possibly be done by listing the species against Vladimir Kostylev's Stable/Disturbed template, plot them on a map and then do comparisons.

The discussion then moved to the available tools and lack of data. The TowCam, fitted with thermister, is a key tool for ground-truthing and hypothesis techniques, and that the Roxanne, ADCP, etc., can be run simultaneously from the ships. For the lack of data, not all data sources have been explored, but with the corals study, the distribution came from the fishermen, which further amplify the need to incorporate [fishermen] information that is not captured on images.

REVIEWERS' COMMENTS ON BENTHIC CLASSIFICATION MODEL

External Reviewers: Bruce Hatcher, Glen Jamieson, Tom Noji, and Mark Costello

The presentations on the second day were instrumental in providing better understanding and in clarifying the paper on the classification model. It was suggested that the model is perhaps 3-dimensional: Disturbance vs. Average Temperature vs. Ability to tolerate temperature change:



- The three-dimensional biological model is very important: it will help link the processes.
- This is for the Scotian Shelf, Canada/US to work on. Plot and characterize species based on climate and then fill-in the geology and biology – an important conceptual concept that should have been done.

The reviewers relayed to the participants their perceptions and observations on the habitat classification. They also highlighted some of the pressing needs/gaps that should be fulfilled prior to moving forward, and closed the session with suggestions on the next steps. Amongst the observations that took centre stage was the emphasis on what has yet to be produced: maps of benthic communities: the rationale for making this statement was captured on a PowerPoint presentation (appendix 4).

Habitat classification is perceived as being more of a function of habitat template for the offshore: a tool for evaluation/vulnerability with a potential to be an important management tool, in particular the stress gradient axis from disturbance to adversity: however, we have to come back on classification.

It was observed that a map of the ecological system for the Scotian Shelf would allow for the full range of human activities on and around the Scotian Shelf to be zoned & regulated, in an effort to maintain the integrity of the ecosystem. Similarly to the mapping of the classification system, this would equally be a dynamic and evolving process. Other observations raised the requirements to establish definitions/ concepts currently used and clarify common terminology such as "Benign/Adverse" for better understanding.

The panel also touched on some of deficiencies which, in some degrees, impede the ability to move ahead with the next phase. While there are gaps in surveys because of the limitations associated with the method used (multi-beam, sonar, etc), the most prominent one is the well-known lack of expertise and knowledge on small scales. The need to know and identify areas that are rare, vulnerable and unique was raised and to that end it was proposed to complete an analysis and discuss the effects of human impacts that are happening in locations of adverse impacts. Other areas for consideration would be to begin associating the pelagic processes to the benthic (the mixed-layer depth regulates food supply) and incorporating productivity.

The next steps propose an analysis on benthic biology within the next two years, a Working Group to focus on the identification of adversity/disturbance, and apply this model to the West Coast to promote a DFO National approach rather than a regional one.

Discussion

The discussion that followed this session was essentially on management advice: besides providing advice on which advice to provide, what advice do you give management.

Before suggesting ideas, it was recognized that the ability/capability to proceed is based on the scientific knowledge currently available, without the benefit of having [produced] maps of benthic communities; however, is it necessary to know everything to make wise decision? Before advocating for additional research in order to move forward, it would be reasonable to determine the usability of the current information for management purposes, including assessments on the ramifications of going with assumptions compare to the added value of additional research/maps.

One of the suggestions was to identify rare areas and monitor management impacts and provide managers with advice on uniqueness and vulnerability. This could be achieved with maps of habitat (climatic) and pinpoint habitat types in each zoning. As a start, ground-truth and plot existing data (within DFO and private sector) in key areas or specific communities.

Another aspect this group should rather target would be on regulating human activity, which could be better than targeting how much biodiversity there should be, such as using the arbitrary scales of the MMU (Minimum Mapable Unit) to map the distribution of habitat and incorporating the benthic diversity type and relation of habitats with what lives there.

A definite approach is to be pragmatic, yet logical with clear goals. This is an appropriate opportunity to task a Working Group to assess what we need, what we have, and translate what has transpired.

REVIEW ON HUMAN IMPACTS

Conference Speakers' Comments (Dave Wildish and Bob Rangeley)

It would appear that the preferred approach to achieve our goal (maintenance of the diversity of the ecosystem types) is to find a single solution rather than looking at new methods for decision support with improvement along the way. We have to make the best of what we have while managing our expectations in regards to classification and data: we do have guidelines for management that could be immediately developed and implemented, we have management tools (MARXAN, MPAs, habitat template and layers), and we have data.

From the WWF's perspective they see their involvement as a complementary one. The use of MARXAN (a tool that is transparent, flexible and target clearly defined areas that are both unique and representative areas) is strongly endorsed in developing needed classification planning units and optimizing site selections, as both management (including long-range system-wide planning) and conservation have to happen now .

Areas to build on:

Models ⇒	○ Work on the Southwood and the Sala et al. approaches: the way ahead. ○ Develop models to answer questions and do more research to support them
Studies ⇒	Trawling activities: ▪ Major activities; ▪ Recovery; ▪ Frequencies of trawling impacts
Research ⇒	○ Benthic; ○ Equipment; ○ multibeam acoustic method; and ○ ground-truthing
Expansion ⇒	○ Gulf of Maine and develop partnerships with the U.S. (ecologically)
Data & Mapping ⇒	○ Options on how to deal with the remaining data gaps (multibeam and samplings) ○ The cost of mapping (on a per-unit basis); and ○ Prioritization

Discussion

It was commented that the template is a good start at a management tool that can be used and applied to oceans management. To illustrate, the zoning schemes developed for *The Gully MPA* were based on ideas of disturbance and adversity, more on a gut feeling basis rather than a model. MPAs are only a small part of the tool box that goes into this.

The Chair closed this session by thanking the external reviewers and conference speakers for their reviews and synthesis of existing information. The session then promptly moved to an open discussion on human impacts.

Open Discussion on Human Impacts

The discussion reiterated the point made throughout the workshop of having an ocean use map that would describe the activities that is going on for the whole zone, including the intertidal zone originally excluded due to data availabilities.

Since the objectives of this Benthic RAP are to provide fisheries and oceans managers with guidance on the management of human activities (e.g. fishing, oil and gas exploration, shipping to name a few) and contribute/link toward the implementation of DFO's ecosystem-based management, it would follow that the development of our operational objectives specifically address the *management of human impacts – not the management of the ecosystem.* Consistent with this approach, and in the absence of an analysis of the nature of natural disturbance versus human impact, our influence should be directed toward identifying the level of stress, in terms sensitivity and recoverability, the benthic community can sustain from human impacts. We could look at the U.K. sensitivity classification model and how it is being used in the decision-making process. An evaluation of the capacity of the system should follow by having all activities in the same playing field and consider where the shelf is being stressed the most (distinctive and representative areas). If there is an abundance of one habitat, impacts may be minimal, whereas if there is a limited amount of one, it may be relevant. We have to provide the perspective on sensitivity to make these decisions, since sensitivity may not be an issue in a particular habitat type because it is everywhere. The model proposed by V. Kostylev provides an assessment of the level of stress habitats can take. If we view this in the EO Framework, then space is the indicator and percentage of area not disturbed is the reference level.

Although no specific sector was singled out, the fishing industry is one of the activities that can have a major impact on the ecosystem. It would be appropriate to consider characterizing the fishing data by its effects on benthic and pelagic species. Most of the required fishing efforts information is available, yet not uniform (individual stock basis, some at the scale of NAFO division, and statistical area scale, paper based) and would need to be interpreted by a competent authority. Overlaying all of this with the confidentiality issues may add to the challenge of making it public.

The remainder of the discussion generated ideas as to what needs to be done on a short term using working groups to carry on specific activities/tasks:

Sensitivity analysis:

- Move ahead with examining the fisheries sector in terms of looking at activities with spatial information. An overall assessment of the knowledge of the impacts of fishing gear around the world, not just trawling, but scalloping, dredging, longlining, and all fishing gear. There are a number of reviews available on this, both national and international. We could do an overview of impacts of different gears on habitats and organisms that are most sensitive.

Mapping:

- Map the distribution of historical and present fishing efforts starting with Stratis Gavaris and Dave Kulka's work and build in other fleets.
- Look at where there is past damage and what are the concerns.
- Incorporate biological information with the model. Review the proceedings on the *Symposium on the Effects of Fishing Activities on Benthic Habitats: Linking Geology, Biology, Socio-economics, and Management* – Nov 12-14, 2002].
- Identify what is feasible and practical

Management options:

- It is the responsibility of DFO, as part of this process, to go out to the community, consult stakeholders within a reasonable timeframe to solicit their review and comments on these maps, as well as to fill in the details.

We ought to be transparent in our processes and use best practices and models. This doesn't mean we cannot move forward with what we currently have.

HABITAT STATUS REPORT (HSR) AND NEXT STEPS

The Chair, External Reviewers panel, and Bob O'Boyle presented a synopsis of the workshop and introduced a proposed table of contents for an HSR report (Appendix 5) as well as a logical course of action (Appendix 6).

Habitat Status Report (HSR)

The discussion started with a short deliberation on the type of documents that will be used to report the outputs of this workshop. The original intent was to use the *HSR* format; however, it was decided to use the *Proceedings* series to capture and report decisions, recommendations, major points of discussion and to reflect the diversity of opinion presented in the discussions. It was also indicated that for us to use an HSR, we need a product and so far what we have is a potential tool that assesses the vulnerability of the benthic environments and still needs further research and ground-truthing.

This perception of not having a product initiated some feedback from the participants. It was pointed out that there are indeed two products: 1) a set of maps; and 2) a methodology, and the broad consensus on the methodology is the product of this RAP. It was then agreed to go ahead with the proceedings of this workshop and an HSR at a later date, since an HSR implies some form of Status Reports (SR).

Next Steps

The development of this benthic classification scheme should progress more along two parallel lines. The first should address the science needed to support the approach and the second for its management application. The science activities would include examining patterns in the benthic community, the types of seascapes, assessing the disturbance of these systems. The management application should address the uses of the ocean and appropriate scales of application. It was suggested during the session that this could be advanced by beginning to draw lines on the maps and to start to fit what we know about communities into these areas. This will provide a basis for identifying patterns in our benthic community types, seascapes that we can use in assessing whether current activities are disturbing these seascapes unsustainably. This can then relate to the effectiveness of our plans and regulations. It was pointed out that John Roff's work with WWF has come up with with a logical, detailed process for drawing lines on a map and although the approach differs, the results are similar.

Another important aspect of the approach relates to resolution and scaling. It is important to keep in mind the difference between resolution and scale: a high resolution window is required to demonstrate scaling. You can input the best resolution data and scale down or zoom to an area when you have the information to support it. This may be possible with Vlad's model in some areas (i.e. Browns or Georges Banks). Once we have identified those areas where there is negative interaction between human use and the ecosystem, they can be used to plan ground-truthing and carry out validation of the model results.

Although we are continuing to develop management actions incrementally through ESSIM and The Gully, we should also investigate the use of tools such as MARXAN.

Mapping of ocean uses and identifying indices of sensitivity and resilience were two items identified as important to the process. Through this you would identify areas of the shelf where the highest level of data is needed for management support, as there is a cost involved in using the best resolution (robust data) and it would be unreasonable to do the whole Scotian shelf. This is where adaptive management comes in by directing our efforts where there are sensitive areas with high level of human activity. Consequently, it would be unlikely that we would zoom-in into an area that has already been highly disturbed, unless the intensity of human activity and its effects on the disturbance are known.

Finally participants recognized the need to relate the methodology & outputs to the ecosystem-based management initiatives (e.g. MEQ) nationally. Establishing that the methodology is the product of this workshop, somewhere down the road it would be necessary to test its applicability to other areas through the ground-truthing exercise. If this conceptual model is not transferable, it should be investigated as to why it would not apply to areas outside the Eastern Scotian Shelf.

General observations

We have a new model and it is better than the existing one, however; it seems that there is some reluctance to take the best we can do, because we might draw some conclusions that are inappropriate for use by management. The current model has the whole shelf equally resilient. We should reject the null hypothesis that "*it doesn't work*" before we reject this new model. This is an evolving process and it is important to highlight uncertainties (for management purposes), missing data and gaps.

There are technical aspects of accessing and presenting all this data and how it will be used once the models are in place. There are various infrastructures already in place, such as web mapping tools and database structures. There's a MARIS database-GIS being built to support Coast Guard Search and Rescue at Dalhousie and other universities. The implementation of a new classification scheme should make best use of the evolving new technologies.

Written comments/observations

The written comments/observations submitted by represented organizations were an integral part of the workshop and dealt with as issues were discussed, except for those related to policy. The respective authors of the papers will also address some of the concerns directly with the represented organizations.

APPENDICES

Appendix 1: Meeting Remit

Remit

Meeting of the Maritimes Regional Advisory Process

Maintenance of the Diversity of Ecosystem Types: Benthic Classification and Usage Guidelines for the Scotian-Fundy Area of the Maritime Region

6-8 January 2004

Dartmouth Sportsplex
Nantucket Room
Dartmouth, Nova Scotia

Background

Since passing of the Canada Oceans Act in 1996, DFO has undertaken a number of initiatives towards the implementation of ecosystem-based management (EBM) in Canada. One of these was the development of a set of objectives to guide EBM through a national science workshop (February 2001) and follow-up discussion in DFO's National Policy Committee. Conceptual objectives for diversity, productivity and habitat were defined, with that of diversity considering community, species and population levels. As there are a number of human activities (e.g. fishing, oil and gas exploration) that can impact benthic community diversity, Maritimes Region initiated a RAP in 2001 to provide fisheries and oceans managers with guidance on the management of these human activities consistent with the broader, national, objectives.

The RAP was designed as a multiphase, multi-year process. The phases included the investigation of potential benthic classification schemes, classification of the benthic communities off Nova Scotia and the development of guidelines and best practices to ensure their conservation. The first phase was achieved through a meeting held in June 2001 (CSAS Proceedings 2002/023) at which various

Demande de renvoi

Réunion du Processus consultatif de la Région des Maritimes

Maintien de la diversité des types d'écosystème : classification benthique et lignes directrices d'utilisation applicables au Secteur de Scotia-Fundy, Région des Maritimes

Du 6 au 8 janvier 2004

Salle Nantucket
Dartmouth Sportsplex
Dartmouth (N.-É.)

Renseignements de base

Depuis l'adoption de la *Loi sur les océans*, en 1996, le MPO a pris diverses initiatives de mise en œuvre d'une gestion écosystémique au Canada. Il a notamment entrepris d'élaborer un ensemble d'objectifs de gestion écosystémique lors d'un atelier scientifique national (février 2001) et de discussions subséquentes au sein du Comité national d'orientation du MPO. Des objectifs conceptuels concernant la diversité, la productivité et l'habitat ont été définis, les objectifs de diversité étant fixés à l'échelle de la communauté, de l'espèce et de la population. Comme diverses activités anthropiques (p. ex. la pêche et l'exploration pétrolière et gazière) peuvent avoir des effets sur la diversité de la communauté, la Région des Maritimes a amorcé en 2001 un PCR visant à guider les gestionnaires des pêches et des océans pour qu'ils gèrent ces activités anthropiques de manière conforme aux grands objectifs nationaux.

Le PCR en question est un processus pluriannuel comportant plusieurs tranches, soit l'étude des systèmes de classification benthique possibles, la classification des communautés benthiques du large de la Nouvelle-Écosse et l'élaboration de lignes directrices et pratiques exemplaires destinées à assurer la conservation de ces communautés. La première tranche a été

classifications approaches were discussed and recommendations made. Work on benthic classification and usage guidelines was initiated in 2002, the results of which are to be reviewed at this RAP.

menée à bien lors d'une réunion tenue en juin 2001(Compte rendu du SCCS 2002/023), durant laquelle on a discuté des divers systèmes de classification et formulé des recommandations à ce sujet. Les travaux concernant la classification benthique et l'élaboration de lignes directrices d'utilisation ont été entrepris en 2002, et ce sont leurs résultats qui seront examinés lors de la réunion du PCR dont il est ici question.

Objectives

The geographic focus of the review will be the Scotia-Fundy area of the Maritime Region (4VWX plus 5 up to the US/Canada border). Given the additional complexities of data availability within the intertidal zone, the review will address information beyond the coastal fringe (i.e., deeper than about 10 meters in depth).

The following are the specific objectives of the meeting:

Objective 1. Based on available information and present knowledge, review a proposed classification map of the benthic "ecosystem types" in the study area

Objective 2. Review the categories of impacting human activities, and (to the degree possible) review measures of the impact of each activity on the benthic "ecosystem types" defined under objective one

Objective 3. Provide guidelines and best practices that could be used to manage human activities

Preparations

The preparation of the classification maps requires a high degree of technical input. To better prepare for the RAP, three ½ day workshops will be held during May – September 2003 at BIO to discuss the technical details of the bathemetry / geology, oceanography and biology / classification model. At the same time, a science team will be undertaking work in support of objectives 2 and 3.

Objectifs

L'examen visera le Secteur de Scotia-Fundy, Région des Maritimes (4VWX + 5, jusqu'à la frontière canado-américaine). Compte tenu des difficultés associées à l'obtention de données concernant la zone intertidale, l'information examinée portera sur les eaux situées au-delà de la frange côtière (c.-à-d., les eaux de plus de 10 m de profondeur).

Voici les objectifs précis de la réunion :

Objectif 1. D'après l'information dont on dispose et les connaissances actuelles, examiner une proposition de carte de classification des « types d'écosystème » benthique dans la zone considérée.

Objectif 2. Examiner les catégories d'activité ayant des effets sur les écosystèmes et (dans la mesure du possible) examiner les mesures des effets de chaque activité sur les « types d'écosystème » benthique définis selon l'objectif 1.

Objectif 3. Établir des lignes directrices et des pratiques exemplaires pouvant servir à gérer les activités anthropiques.

Préparation

La préparation des cartes de classification nécessite un haut degré de ressources techniques. Afin de bien préparer le PCR, on tiendra trois ateliers d'une demi-journée entre mai et septembre 2003 à l'IOB. À cette occasion, on discutera des modalités techniques de bathymétrie, de géologie, d'océanographie et de biologie du modèle de classification. Parallèlement, une équipe de scientifiques entreprendra des travaux à l'appui des objectifs 2 et 3.

Based on these discussions, working papers will be prepared and circulated to participants at least two weeks prior to the RAP.

D'après les discussions tenues à ces occasions, des documents de travail seront établis et transmis aux participants au moins deux semaines avant la réunion du PCR.

Products

Produits

Status Report for presentation to various advisory boards and general public. This will be produced by the RAP meeting

Rapport d'état destiné à être présenté à divers organes consultatifs et au grand public. Il sera produit lors de la réunion du PCR.

Research Documents summarizing the technical basis for the conclusions and recommendations in the HSR

Documents de recherche résumant le fondement technique des conclusions et des recommandations du REH.

Proceedings document reporting the discussion of the RAP meeting

Compte rendu relatant les discussions tenues lors de la réunion du PCR.

Participation

Participation

Participation will be by invite, based upon expertize and knowledge, and include the following

Les participants seront invités en fonction de leur expertise et de leurs connaissances. Les secteurs et organismes suivants seront notamment représentés :

DFO
Science
Oceans
Fisheries management
Habitat management

MPO
Sciences
Océans
Gestion des pêches
Gestion de l'habitat

External Experts
Government
Academic

Experts externes
Gouvernement
Milieux universitaires

Skakeholders
Fishing sector
Oil and Gas sector
World Wildlife Fund
Ecology Action Centre

Intervenants
Secteur de la pêche
Secteur du pétrole et du gaz
WWF
Ecology Action Centre

Appendix 2: Meeting Agenda

Tuesday, 06 January 2004

Background

09:00 – 09:30	Introduction & Background (Joe Arbour)
09:30 – 10:00	Review of 1st Benthic RAP meeting (Joe Arbour)
10:00 – 10:30	Break

Classification Models

10:30 – 11:15	Overview of Proposed Habitat Classification Approach (Vladimir Kostylev)
11:15 – 12:00	Habitat Classification Model (Vladimir Kostylev)
12:00 – 13:00	Lunch
13:00 – 14:00	Habitat Classification Model Continued (Vladimir Kostylev)
14:00 – 15:00	A Framework for the Application of Marine Classification for Conservation (Bob Rangeley)
15:00 – 15:30	Break

Human Impacts

15:30 – 16:15	Human Impacts Analysis (Dave Wildish)
16:15 – 17:00	Area Trawled on Georges Bank by Groundfish Fishery (Stratis Gavaris)

Wednesday, 07 January 2004

Reviewers comments on Day One presentations

09:00 – 10:00	Summary by External Reviewers
10:00 – 10:30	Break

Scotian Shelf Benthic Classification Model

10:30 – 11:30	Stability/Adversity Axes (Vladimir Kostylev)
11:30 – 12:00	Discussion
12:00 – 13:00	Lunch
13:00 – 14:00	Geology Indicators (Gordon Fader)
14:00 – 15:00	Oceanographic Indicators (Charles Hannah)
15:00 – 15:30	Break
15:30 – 16:30	Biota Indicators (Don Gordon)
16:30 – 17:00	Discussion

Thursday, 08 January 2004

Reviewer comments on Day Two on Classification Models

09:00 – 10:00	Summary by External Reviewers
10:00 – 10:30	Break
10:30 – 10:45	Recap by Dave Wildish and Bob Rangeley
10:45 – 12:00	Discussion on Human Impacts
12:00 – 13:00	Lunch
13:00 – 15:00	Discussion on Habitat Status Report
15:00 – 15:30	Break
15:30 – 17:00	Next Steps

Appendix 3: List of Documents

Gavaris, S., and J. Black. 2003. *Area Trawled on Georges Bank by the Canadian Groundfish Fishery.* CSAS Research document 2004/018

Kostylev, V.E. 2003. *Habitat management template for Scotian Shelf habitat mapping.*

Wildish, D.J., and P.L. Stewart. 2003. *A geographically-based, ecosystem management strategy for the offshore regions of the Scotian Shelf / Bay of Fundy.*

World Wildlife Fund Canada and Conservation Law Foundation. A Planning Framework for Marine Conservation. Maintenance of the Diversity of Ecosystem Types: Benthic Classification and Usage Guidelines.

Appendix 4: List of PowerPoint Presentations*

A. Introduction and Background	Joe Arbour, DFO
B. Habitat Mapping in Scotia-Fundy Region	Vladimir Kostylev, NRCan
C. Stability/Adversity Axes	Vladimir Kostylev, NRCan
D. A GIS based, ecosystem management strategy for the offshore regions of the Scotian Shelf/Bay of Fundy	Dave Wildish, DFO; and Pat Stewart, Consultant
E. Area Trawled on Georges Bank by Canadian Groundfish Fishery	Stratis Gavaris, DFO
F. Geoscience Layers in Ecosystems Assessment and Management for the Scotian Shelf	Gordon Fader, NRCan
G. The Physical Oceanographic Layers in the Benthic Classification	Charles Hannah, DFO
H. Biotic Indicators	Don Gordon, DFO
I. Layers, Models, and Mapping (Reviewer's Comment – Day 2)	Bruce G. Hatcher

*The complete presentations are available on the enclosed CD.

Appendix 5: Proposed format on RAP Outputs

1. HABITAT STATUS REPORT (exec summary):
    - A. Background
    - B. Summary
    - C. Introduction
    - D. Habitat Characteristics
        1) Benthic community diversity is a response to disturbance & stress (through time!)
        2) Model informed & refined by empirical data & sensitivity analyses
            i. Disturbance axis = mechanical disruption (accepted, clear)
            ii. Adversity axis = physiological stress (debated, unclear)
        3) Measurement parameters for each axis to be stated
        4) Model is coarse – broad scale – low resolution
        5) Model is essentially sound & captures many known patterns (exceptions)
    - E. Uncertainties
        1) Scales & scaling
        2) Applicability to coastal zone
        3) Actual distributions of biotic variates
    - F. Management considerations
        1) Role of the model in oceans management is accepted, with limitations
        2) Application to management of benthic habitat impacts
        3) Consequences of scaling limitations for management
    - G. More Information
    - H. References
        i. Bob's paper referenced
        ii. Trevor's comments referenced

2. PROCEEDINGS:
    How much more scientific research is required before the product can be used for the management map? Gaps? Human vs. non-human components? Existing vs. new data?

3. RESEARCH DOCUMENTS:
    iii. Vlad's paper
    iv. Stratis's paper
    v. Dave & Pat's paper

Appendix 6: Next Steps

1. Map the gross marine habitat (physical-chemical) units of the entire shelf at a coarse scale using existing, robust data.

2. Infer the distribution of gross ecological units (enduring & replicated habitat-community associations = ecosystems) using a refined version of the physiological stress-disturbance model of habitat definition (working group 1).
Map at scales to be determined from statistical analysis of patch scales, approx. 100km2 pixels)

3. Verify with existing and experimental data sets of bio-physical parameters (working group 1) [AM-Feedback loop]

4. Add unique, rare, endangered & vulnerable ecological units derived from other sources than the predictive model (working group 2). Need to identify required skill sets for WGs.

5. Continue ground-truthing & refinement of physical-chemical habitat delineation as $, t, & HR permits according to a priority list identified by the working group 1 (everybody). [Adaptive Management - Feedback loop]

6. Identify & classify the entire spectrum of human activities on & around the Scotian Shelf in terms of impact intensity density (disturbance/unit time/unit area) (working group 3).

7. Assign & map ocean uses at the same spatial resolution as the gross habitat-community maps (working group 3).

8. Assign indices of sensitivity & resilience (recoverability) of the ecological units to various identified human activities (WG 1, 2 & 3).

9. Identify, locate & rank areas of potentially negative interaction between human activities & habitat-community units (WG 1, 2 &3).

10. Use these priority areas to plan ground-truthing and experiments under 2, 3 & 5 (above). [AM-Feedback loop]

11. Use these priorities to inform the ocean management plan with the ESSIM (& other OMAs as applicable) and to investigate how management actions might be implemented. (i.e., through trial management areas).

12. Relate the methodology & outputs to the ecosystem-based management initiatives (e.g. MEQ) nationally.

ANCILLARY ACTIONS

1. Design & fund a focused, well-funded, collaborative research agenda (not just within the DFO). Grant application

2. Explore the application of marine habitat mapping to management as developed in the MARLIN, the MARIS, etc.

3. Formalize data formatting, sharing & presenting protocols for marine & maritime management.

Appendix 7: Letter of Invitation to Participants

Fisheries and Oceans Canada / Pêches et Océans Canada
PO Box 1006
Dartmouth, NS
B2Y 4A2

December 23, 2003

To Whom It May Concern:

Re: **Benthic RAP Meeting – January 6-8, 2004**

As chairperson for the Regional Advisory Process Meeting on Maintenance of the Diversity of Ecosystem Types: Benthic Classification and Usage Guidelines for the Scotian-Fundy Area of the Maritime Region A Benthic Classification System for the Scotian Shelf, I would like to invite you to this event being held January 6, 7 and 8 in the Nantucket Room at the Dartmouth Sportsplex. This is an important step in the evolution of modern Ocean Management tools and your expertise and experience will be much appreciated at this meeting.

Please find attached the agenda for this meeting. You can view the technical papers for the session at the following RAP website.

http://www.mar.dfo-mpo.gc.ca/science/rap/internet/meetings2004.htm (Remit)
http://www.mar.dfo-mpo.gc.ca/science/rap/internet/workingpapers2004.htm

1) Progress report on interdepartmental initiative on benthic habitat mapping in Scotia-Fundy region. By: Vladimir Kostylev
2) A geographically based, ecosystem management strategy for the offshore regions of the Scotian Shelf / Bay of Fundy. By: D.J.Wildish and P.L.Stewart
3) Area trawled on Georges Bank by the Groundfish Industry. By: Stratis Gavaris
4) A Framework for the Application of Marine Classification for Conservation. By: Bob Rangeley

If you have any questions regarding this meeting, please feel free to contact me at 902-426-3894 or email to Arbourj@mar.dfo-mpo.gc.ca or Melissa McDonald at 902-426-9919 mcdonaldm@mar.dfo-mpo.gc.ca.

Yours sincerely,

Original signed by:

Joseph H. Arbour, Ph.D.
Division Manager
Oceans & Coastal Management Division
Maritimes Region

Appendix 8: Meeting Participants

Acadia University	Roff, John	DFO	Arbour, Joe
CNSOPB	Palmer, Erin		Black, Jerry
Consultant	Rutherford, Bob		Boudreau, Paul
	Stewart, Patrick		Bradshaw, Valerie
Dalhousie University	Hatcher, Bruce		Breeze, Heather
	Ricard, Dan		Bundy, Alida
	Smith, Jennifer		Coffen-Smout, Scott
	Willison, Martin		Costello, Gerard
Ecology Aaction Centre	Butler, Mark		Fenton, Derek
FRCC	Gregory, Gabe		Gavaris, Stratis
Groundfish Enterprise Allocation Council	Chapman, Bruce		Gordon, Don
			Hackett, Jennifer
Huntsman Marine Science Centre	Costello, Mark		Hall, Tim
	Rose-Taylor, Candace		Hannah, Charles
Industry	Walters, Evan		Hansen, Jorgen
Inshore Fisheries	D'Entremont, Claude		Harding, Gareth
MACO	Yeadon, Maureen		Herbert, Glen
NOAA	Noji, Thomas		Jamieson, Glen
NRCan	Fader, Gordon		Lamplugh, Mike
	Kostylev, Vladimir		Lundy, Mark
	Todd, Brian		Macnab, Paul
NS Energy	Doane, Kim		McMaster, Andrew
NS Fisheries	Reardon, Clary		Meade, James
PWGSC	Barbour, Stephen		O'Boyle, Bob
	Frigault, Nicole		Peacock, Greg
	Maynard, Don		Sinclair, Mike
Scotia-Fundy Mobile Gear Association	Giroux, Brian		Siron, Robert
			Smith, Stephen
SPANS (Seafood Producers Association of Nova Scotia)	Stirling, Roger		St-Laurent, Bob
			Strain, Peter
WWF	Berry, Jody		Strong, Mike
	King, Marty		Tremblay, John
	Rangeley, Bob		Vandermeulen, Herb
	Hawkins, Christopher		Wildish, Dave
			Worcester, Tana